

REMARKS

The Amendment and these Remarks are filed in response to the Office Action mailed June 7, 2007 in the captioned application. Claim 1, 4, 7, and 9 has been amended. A new claim 31 has been added. Claims 1 and 8-24 are pending the application. Support in the specification for the limitations added to claim 1 can be found as follows (please note that the ¶ numbers in published application US 20050148065 are two higher of those in the application, which are used here):

for “a substrate” -at ¶ 28, l. 1;

for “a film bulk acoustic” resonator -at ¶ 27;

for a resonator “attached to the substrate at its edges” -at ¶ 26, l. 5;

for piezoelectric material “sandwiched between a pair of electrodes” -at ¶ 26, l. 4;

for control circuitry “comprising a signal generator”-at ¶ 39, ll. 1-3;

for an excitation signal “that includes a plurality of frequencies”-at ¶ 42 ll. 2-3;

“processing circuitry to determine the impedance of the resonator as a function of frequency” at -at ¶ 42 ll. 7-9

for “the mass, or the electrostatic charge or both, of the target molecules that have reacted with the functionalized surface causes a detectable change” -at ¶24, ll. 9-12.

No new matter has been added. Support for amended claim 4 can be found at ¶ 32, l. 4. Claim 7 has been amended to add the limitation of originally filed claim 9, in order to be consistent with the parent claim as amended. Claim 9 has been amended to incorporate the limitation of originally filed claim 8.

The limitation of claim 1 concerning a second piezoelectric resonator that had been introduced by the previous amendment has now been deleted, and has been reintroduced as dependent claim 31. Support for this amendment can be found in originally filed claim 3.

Claim Rejections - 35 USC 102

None pending

Claim Rejections - 35 USC 103

Claim 1 was rejected as obvious over Ward (U.S. patent No. 5,501,986) in view of Gao (U.S. patent No. 6,218,507). Ward discloses the use of a quartz crystal piezoelectric oscillator to detect changes in weight that result from a binding reaction. The disclosure of Ward is alleged to have disclosed the elements of claim 1 except for the presence of a second comparator resonator lacking a functionalized surface. The device of claim 1 prior to the present amendment allegedly differed from the combination of Ward and Gao only in reciting a film bulk acoustic resonator (FBAR) in place of the quartz crystal found in the combination of Ward and Gao. That defect is allegedly remedied by Yamada (U.S. patent No. 6,842,088), which describes FBAR-containing sensor.

Applicants respectfully traverse. The device described by Ward functions in a substantially different way than the Applicant's invention (the "Invention"), a way which is less sensitive and more cumbersome. Referring to Figure 1 of Ward, which was kindly provided in the Office Action, the target molecule which is to be detected in the soluble form of **20**. The assay is performed in a competition mode between the analyte that is membrane bound and soluble **20**. Ward, Col. 4, ll. 38-44. The competition results in more or less binding of the modified sol particle (the combination of **24** and **26**. Col. 3, ll. 59-65.) The resonant frequency change is due to the binding of the modified soluble particle not the analyte. Col. 4, ll. 44-49. In the device of Ward the presence of the target molecule inhibits binding and cause a reduction in the resonant frequency. By contrast in the Invention, the mass and/or electric charge of the bound target molecule directly

causes a change in the frequency response. It is evident that the Invention has the advantage of great simplicity and sensitivity compared to the device of Ward. Applicants' Invention further encompasses their use of changes in the resonator, in addition to the changes caused by changes of mass. The use of these additional factors is no where taught or suggested by Ward or any other prior art of record. Indeed, detecting such changes in Ward's device would be impossible since it is the presence of the analyte causes an inhibition of detectable binding to the oscillator. More specifically at ¶ 16, Applicants teach:

The reaction of the target molecules with the functionalized surface causes changes in the mass and/or charge of the resonator, stress/strain, surface energy/tension and the like, which cause changes in the vibrational characteristics of the resonator. Changes in the vibrational characteristics of the resonator may be manifested through corresponding changes in electrical characteristics of the resonator.

To achieve these advantages the Invention employs control circuitry, which is different than Ward's. The control circuit of Ward, which is described as Figure 4 of his patent, consists of an amplifier (MC1733), with positive feedback, whose output drives a quartz crystal piezoelectric device (HTAL) and whose input is grounded through the piezoelectric device. The circuit is an oscillator whose output consists of a single frequency corresponding to the resonant frequency of the HTAL. The device functions by relating changes in the resonant frequency to different concentrations of the target molecule. Thus, in the device of Ward the "signal generator" and the "processing circuitry" are integrated together, the oscillator serves both to generate the signal and determine the resonant frequency of the resonator, which is the only characteristic of the resonator's frequency response that is determined by Ward. Consequently, the exciting signal consists of a single frequency and the output of the device consists of a measurement of that frequency. By contrast in the Invention, the exciting signal includes a plurality of frequencies and the processing circuitry detects the impedance of the FBAR as a function of frequency, which is termed the "frequency response" of the resonator. As the Examiner knows, the frequency response of the resonator is minimally characterized by two frequencies, those of maximum and minimum impedance and a Q value related to our of phase resistance.

Applicants respectfully submit that the combination of Ward and Yamada does not suggest the Invention. Indeed, because Yamada teaches no control circuitry, their combination is the device of Ward modified because the quartz crystal is replaced by an FBAR. The combination cannot use a plurality of exciting frequencies because the signal generator is an oscillator with a single resonant frequency, which is determined by the conditions of the HTAL. The combination cannot determine the electrical impedance of the resonator as a function of frequency because the excitation signal consists of a single frequency. Accordingly Applicants respectfully submit that the disclosed measurement and control circuitry is incapable of performing in a way that meets the limitations of the Invention. Therefore, the combination of Ward and Yamada do not suggest the Invention.

Because the Invention of claim 1 is not suggested by the combination of Ward and Yamada, Applicants further respectfully submit there is no suggestion of the Inventions of any of dependent claims 8-30.

Applicants further submit that the Karube that the present amendments also distinguish (U.S. patent No. 4,789,804). Karube discloses a device which is substantially similar to that of Ward. In particular, Karube employs an oscillator circuit to provide a single frequency stimulating signal that is determined by the resonant frequency of the piezoelectric resonator. From Ward in that it is used not in a competition mode but in a direct mode. However, Karube is not described as a general purpose biosensor. Rather Karube is specifically directed towards the detection of massive targets such as yeast, bacteria or red blood cells, or towards the detection of macromolecules present in high, *i.e.*, at least 10-100 microgram/ml, concentrations. Even under these limited circumstances, Karube teaches the use of antibody coated “latexes” to amplify the signal. See Karube at Col. 6, l. 55. It is evident that the combination of Karube modified by Yamada would also suffer from the defect of Ward as modified by Yamada.

CONCLUSION

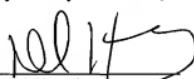
In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

The Examiner is respectfully requested to contact the undersigned at the telephone number indicated below if the Examiner believes any issue can be resolved through either a Supplemental Response or an Examiner's Amendment.

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Respectfully submitted,

By


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